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RESEARCH DEPARTMENT



REPORT

Electronic soft-focus unit

No. 1971/5

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H.A.S. Philippart, C.Eng., M.I.E.R.E.

(PH-72)



Head of Research Department

ELECTRONIC SOFT-FOCUS UNIT

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ELECTRONIC SOFT-FOCUS UNIT

Summary

A unit is described which processes the luminance signal of a colour camera so that the two dimensional frequency response approximately resembles that of a soft-focus lens. This is achieved in the line direction by processing the video information in two parallel paths, in one of which a 'sine-squared' network is inserted, the other containing a delay to compensate for the transit time through the sine-squared network. Soft focus in the vertical direction is given by a vertical aperture corrector in which the correcting signals are phase inverted and suitably adjusted in magnitude. Experimental trials with a laboratory version of the equipment show that it can produce the desired effects of soft focus.

1. Introduction

This work was undertaken as a result of a request by the Head of Television Design Group for an electronic means of producing a soft-focus effect. The need for such an effect is given in the following quotation¹ 'the realism of colour and the acutance of the camera is so effective that in close-up every blemish, blotch or wrinkle in the human face will be revealed, so if the older person is to feel secure the picture needs to be softened or diffused as a photographer would with soft-focus lens — in television electronic means will be found to 'romanticise' the picture by softening it without losing its essential sharpness.'

To the above can be added the possible requirement for relatively low definition in night scenes and moonlight scenes. The camera's high resolution is unnatural under these conditions as normal vision cannot resolve fine details at low light-levels.

For ease of operation, soft-focus should be applied by simple switching. Any method requiring fitting of filters or other optical devices on the lens would be inconvenient.

2. Photographic soft-focus

Various methods are used in photography to obtain soft-focus. One method is to use a soft-focus lens, that is a lens which has not been fully corrected for spherical aberration. By suitable stops positioned on the front of the lens (Fig. 1) the relative contributions of the image of the central and peripheral rays can be varied, thus giving different degrees of softening (diffraction effects also limit the definition of a lens when it is appreciably stopped down). This method is inapplicable to the highly-corrected type of lenses now used in television.

Another method is to fit on the front of the lens a transparent disc on which concentric rings have been engraved. In this case, in addition to small changes in the image plane for rays passing through the grooves in the disc (thus producing softening), flare may be produced, which causes a loss of contrast, and a loss of overall transmission. A third photographic method is to insert two sheets of glass of different dispersion, thus producing chromatic aberration. This method is obviously inapplicable to colour cameras.

Common to all three methods is the requirement that the aperture (iris) would have to be readjusted when soft-focus is required, this feature appears to be definitely unwanted in television practice.

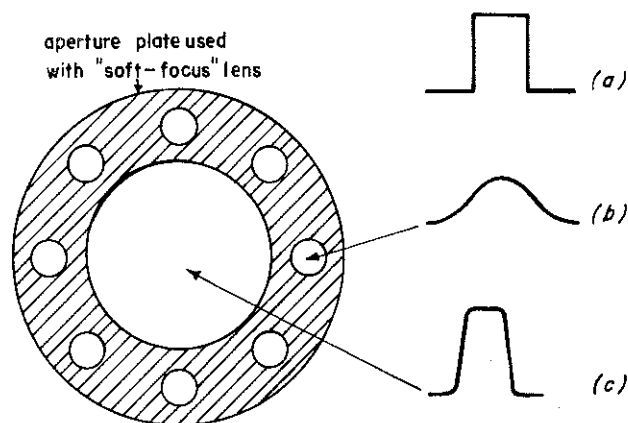


Fig. 1 - Production of soft-focus effect by lens with partially covered spherical aberration

(a) Test object (b) Peripheral rays (c) Central rays

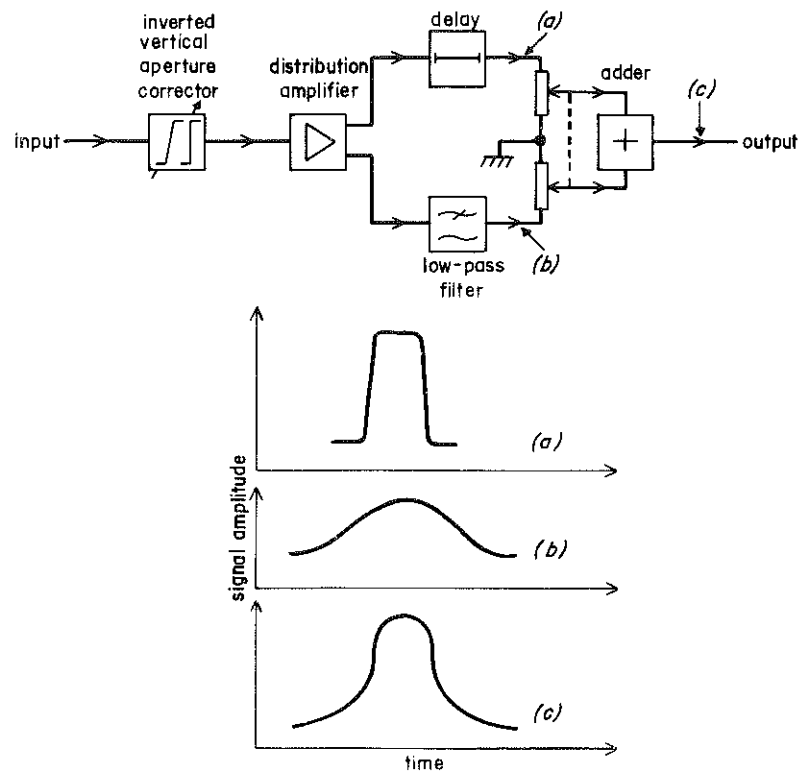


Fig. 2 - Block diagram and waveforms of electronic soft-focus unit
(a) Delayed signal (full bandwidth) (b) Filtered signal (c) Combined signal

A fourth method is the use of Canon 'Contimat' filters² positioned in front of the lens. These filters are used mainly for removing 'moiré' patterns or patterns in photoengraving or photolithography. A filter consists of many transparent thin film discs (about $1/4000$ mm thick) evaporated on an optically-flat glass. The characteristic of this filter is determined by the diameter and random distribution of these thin discs (2, 2, 8, 4, 5.6 and 8 mm diameter). Even though these filters were originally designed for printing processes they could be used for 'soft-focus'.

To prevent confusion, it may be useful here to note the difference between soft-focus produced by a camera and that produced by printing. In the former case the highlights edges are spread into dark areas. In the latter case, operating from a negative image, the opposite occurs and, in the print, shadows are spread into highlights. These conditions produce very different effects.

3. A television analogue

In television a 'soft-focus' analogue may require to be carried out in two steps, namely in the horizontal and vertical directions. In the horizontal direction a fairly simple analogue system can be used. Fig. 2 shows a block schematic of a suitable arrangement and various waveforms. The Y signal from the vertical aperture correction unit is connected to a distribution amplifier. One output is used to feed a sine-squared low-pass filter whose characteristic is approximately -6 dB at 750 kHz, a second output feeding a wide-band delay line adjusted to compensate for the inherent delay in the filter path.

Outputs of the filter and delay line are connected across two ganged 75 ohms potentiometers. Connections are such that an increase in one output corresponds to a decrease in the other. When added they provide a constant amplitude output at the lowest frequencies (Fig. 3) but of variable attenuation at higher frequencies, since the high-frequency components are attenuated in the low-pass filter. The same effects also take place in an optical system.

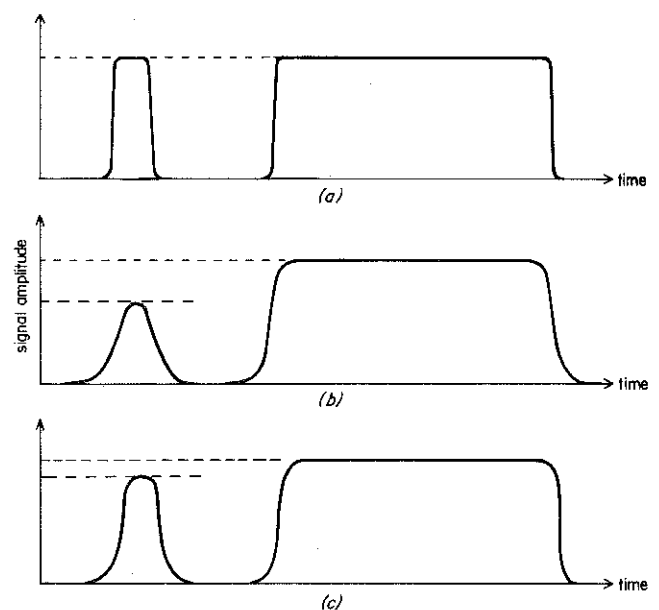


Fig. 3 - Waveforms illustrating various degree of soft-focus
(a) Original signal (b) Maximum softening (c) Partial softening

In the vertical direction, due to interlace the true optical analogue cannot easily be obtained. It is, however, necessary to simulate to some extent the soft-focus effect in order to obtain a balanced (non-astigmatic) picture. Fortunately, it has been found that a small amount of 'inverted' vertical aperture correction (Fig. 4) provides a satisfactory answer. This can be done by means of a slightly modified version of the vertical aperture correction units now in use.

4. Apparatus

The horizontal 'soft-focus' unit consists of four CH/1A3 chassis:

1. Distribution amplifier
2. Filter, delay line, control potentiometers and relay
3. Adder
4. Power supply unit.

The vertical unit is the standard Designs Department vertical aperture corrector Type UN3/519/1, modified to operate in an inverted condition.

5. Controls

Controls can be either continuously variable or preset and brought into operation by relays. This is best decided by operational staff after experimental trials.

6. Results

Tests were carried out on an EMI Type 2001 four-tube colour camera, horizontal and vertical units being inserted in the luminance signal path in the linear mode (i.e. before gamma correction). Various subjects were observed and the softening found to be satisfactory. Only very little inverted vertical aperture correction was required. It was also noticed that the amount of softening as shown by sample photographs supplied by Television Design Group appeared excessive when seen on a large television screen. Here again the precise amount of correction will have to be assessed by operational staff.

7. Conclusion

An electronic soft-focus unit has been designed and a prototype constructed in which a 'soft-focus' effect can be achieved when the unit is inserted in the luminance channel of a colour camera.

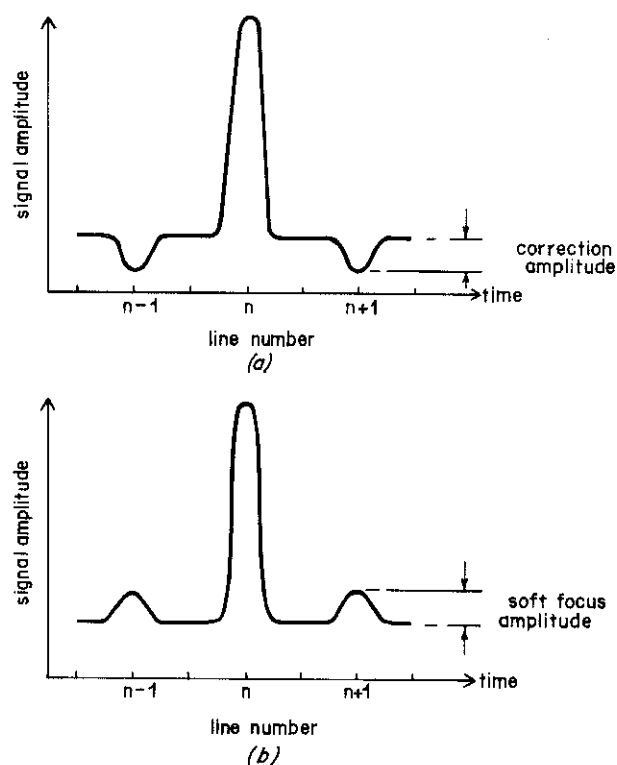


Fig. 4 - Waveforms generated in a vertical aperture corrector (VAC)

(a) in normal operation (b) in soft-focus application (inverted)

8. References

1. LEVIN, R. 1968. Television and design. BBC Lunch-time Lectures, 1968, 7th Series/3.
2. Filters made by Canon Camera Company, Tokyo, Japan.

9. Acknowledgement

Our thanks are due to R.J. Taylor of Designs Department for the loan of the vertical aperture correction unit and for useful suggestions.

